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Interactive comment on "A simplified permafrost-carbon model for long-term climate studies with the CLIMBER-2 coupled earth system model" *by* K. A. Crichton et al.

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In their manuscript "A simplified permafrost-carbon model for long-term climate studies with the CLIMBER-2 coupled earth system model", Crichton et al. describe a new component added to the CLIMBER-2 model and report performance of this module. The fate of permafrost carbon under climate change is a novel, challenging topic. The manuscript is in a good shape, but needs better handling of equations and terminology.

General comments.

One of my concerns is about misleading and confusing terminology used in the manuscript. For example, in the abstract they write about "soil decay", while the pro-

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cess they consider is not the soil evolution (formation and degradation of soils), but decomposition of soil organic matter (SOM). They conclude that "the distribution of this permafrost-carbon pool is in broad agreement with measurement data for soil carbon concentration per climate condition." What do they mean under climate conditions: a temperature in the particular geographical location at present or does it mean sensitivity in past climates? Why do they use a term "concentration" and not "storage" used e.g. by Hugelius et al. or "content" and "density" as in most of papers on SOM distribution and modelling? Concentration is usually used for liquids and gases, not solid matter. This misleading terminology is really annoying for a reader who tries to understand what exactly is done by the authors.

My other concern is that the authors simulate the permafrost carbon dynamics with one-pool model, while multiple-pool models with several turnover times usually show much better agreement with data. They also have several tunable parameters, e.g. a and b in Eq. 3. How many degrees of freedom does the model have? If one do just a global one-box model of permafrost carbon with the same degrees of freedom, wouldn't it show similar dynamic behavior? What is an advantage of using spatially distributed model of permafrost carbon, if there is just one-pool model?

Specific comments.

p. 4935, l.26: "a possible explanation for the 13C record". Usually, 13C is referred to marine data, not atmospheric data (13CO2).

p. 4936, l. 11: "... carbon-13 tracer in its global carbon cycle model, ice sheets and carbonate compensation in ocean waters (Brovkin et al., 2007) as well as ocean biochemistry." This is a funny mixture of carbon and physical components (ocean bio-GEOchemistry, ice sheets) and processes (carbonate compensation). The component needed to model the carbonate compensation is called "deep sea sediments".

p. 4937, l. 19: Instead of explaining equations in words (which could be easily misinterpreted), the authors could demonstrate that they know how to write equations behind

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the model code and provide a first-order kinetic equation for SOM dynamics, e.g. in the form

dC/dt=F_litter-C/tau

and explain that F_litter is the litter flux, C/tau is the soil respiration flux for which they could also use another notation, eg F_resp. They also should provide units for all fluxes and stocks (e.g., kgC/m2/yr, kgC/m2) and say that the equation is numerically solved with a time step of 1 year.

Eq.2: The term T_soil should be noted as T_ref equal to 5°C in the CLIMBER-2 code. The term c should be tau_ref (turnover time for a reference temperature). Units (years) should be provided in this and next Eq. 3.

Eq.4: what are units for degree-days?

Section 2.5, Figs. 5, 6, 16: comparison of models and data should be done on the same spatial resolution (fine-scale data should be upscaled to the coarse resolution of CLIMBER2).

Table 1 title, section 4 title: "develop, tune and validate the permafrost-carbon mechanism." How one can do tuning and validation of the model using the same set of data? For validation, the data should be independent from the data used to tune the model, otherwise it is a circular logic. It is more correct to say that the model is tuned to get the best fit.

P. 4953, l. 5: "The model has no soil 'depth' (only a carbon pool) so 14C cannot be used as a useful tracer as part of CLIMBER-2P in its current configuration. The CLIMBER-2P model does have a 13C tracer within the carbon cycle which is intended to be used in conjunction with the permafrost model to constrain carbon cycle dynamics." Why 14C cannot be used as an atmospheric tracer, similar to 13C?

Interactive comment on Geosci. Model Dev. Discuss., 7, 4931, 2014.